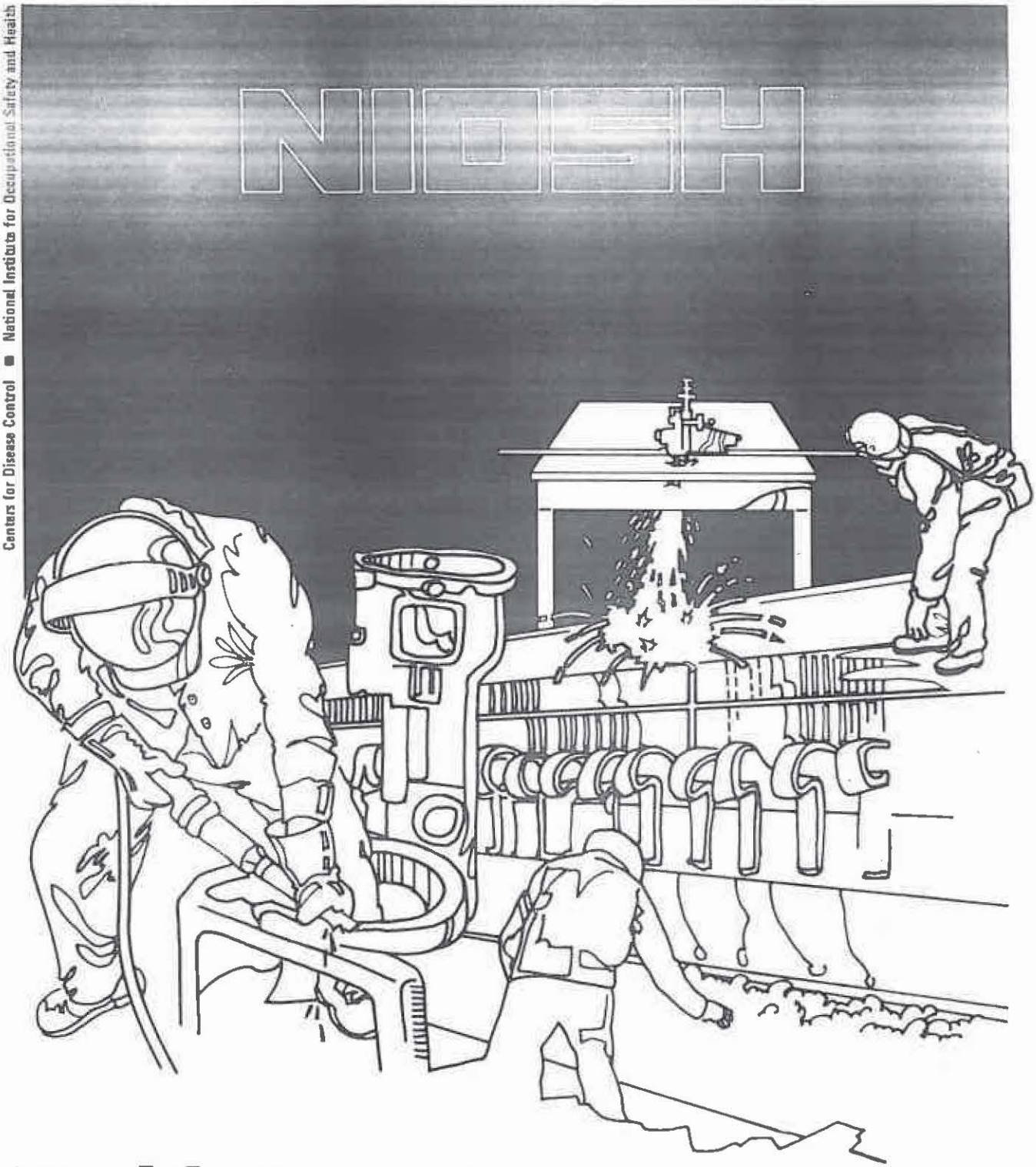
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HHE 80-033-815
ASARCO, INC.
HAYDEN, ARIZONA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 699(a)(6), which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HE 80-033-815
February 1981
ASARCO, Inc.
Hayden, Arizona

NIOSH INVESTIGATORS:
Arvin G. Apol, IH
Molly Coye, M.D.

I. SUMMARY

In December, 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from the authorized representative of the United Steel Workers Local 886 to evaluate the potential health hazard of exposure to arsenic, cadmium, copper, lead and sulfur dioxide in the pug mill department of the ASARCO, INC. Smelter, Hayden, Arizona.

An initial survey was conducted on March 5, 1980, and an environmental/medical survey on April 23 and 24, 1980. Personal (breathing zone) and area samples were collected for airborne arsenic, cadmium, copper, lead, and sulfur dioxide. The medical evaluation included blood, lead, and urine arsenic determinations.

Environmental data indicated no overexposure to cadmium or to sulfur dioxide. Arsenic concentrations in all four of the personal samples (24, 94, 14 and 32 ug/cu m) exceeded the OSHA standard of 10 ug/cu m, one of four for copper dust (2.16 mg/cu m) exceeded the OSHA standard of 1 mg/cu m and one lead sample (95 ug/cu m) exceeded the OSHA standard of 50 ug/cu m. Respirators were worn by the workers when working in dusty conditions.

All 3 blood lead levels were below 40 ug Pb/100 ml. One pug mill operator was found to have a urine arsenic level above 100 ug As/l and all 3 had levels above 50 ug As/l. (56, 78 and 130 ug/l).

On the basis of the data obtained in this investigation, NIOSH determined that a potential hazard from overexposure to arsenic, copper, and lead existed in the pug mill department of the ASARCO Smelter. These potential hazards are reduced by the periodic use of respirators. Recommendations concerning control of exposures to airborne metal dust are included in Section VIII of the report.

KEY WORDS: SIC 3331 (Primary Copper Smelter) Arsenic, Cadmium, Copper, Lead, Sulfur Dioxide.

II. INTRODUCTION

In December, 1979, NIOSH received a request from the authorized representative of the United Steel Workers Local 886 to determine if a health hazard existed from exposure to arsenic, cadmium, copper, lead, and sulfur dioxide in the pug mill department of the ASARCO Smelter, Hayden, Arizona. An initial survey was conducted on March 5, 1980, and an environmental medical survey was conducted on April 23 and 24, 1980. A written report, including environmental results and recommendations, was submitted to the company and union on August 6, 1980. Medical results were mailed directly to the individuals tested, and a summary of those results is included in this report.

III. BACKGROUND

ASARCO'S Hayden, Arizona, facility is a primary copper smelter. This evaluation involves only the pug mill. The flue dusts and gases from the roaster pass through a series of electro-static precipitators. The dusts, which contain arsenic, cadmium, copper, lead and traces of other metals, are shaken loose from the collectors and settle in a series of hoppers. The dusts are removed from the bottom of the hoppers by screw conveyers and proceed to the pug mill where they are sprayed with water, dropped on a pile and removed by a front-end loader.

The pug mill operators are on dayshift only, seven days a week, with five employees rotating work days.

The employees in this area are issued NIOSH approved cartridge respirators. They are worn when they enter the area under the hoppers and elsewhere when they are in an obvious cloud of dust. The dust comes from leaks in the hoppers and screw conveyers and from the road past the pug mill when vehicles pass by. The coveralls are laundered by the company. Showers and clothing changes are urged, but not mandatory.

Medical Facilities

Two nurses are working in the plant, but they do not cover all the shifts. Patients needing to see a physican are referred to a physician retained full-time by the company but practicing in a community clinic. Pre-employment medical testing consists of spirometry (begun eight months prior to the initial NIOSH survey) blood lead levels (done since approximately 1950), and lumbar spine X-rays. Blood lead levels are repeated annually for all workers; urine arsenic is not measured on a periodic basis because no elevated levels had been discovered in past monitoring. The workers do not receive any training on the potential health hazards of lead, arsenic or sulfur dioxide.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Breathing zone and area air samples were collected for arsenic or cadmium, copper and lead on celluose-ester membrane filters which were preceded by potassium hydroxide-treated filters used to collect sulfur dioxide. All samples were collected at a flow rate of 1.5 liters per minute. Additional information regarding collection and analysis is shown below.

SUBSTANCE	COLLECTION MEDIUM	ANALYTICAL METHOD	LIMITS OF DETECTION
Arsenic	Celluose ester membrane filter	Hydride generation	25 ng/filter
Cadmium	" "	NIOSH method PC&AM 173	2 ug/filter
Copper		" "	2 ug/filter
Lead	" "	" "	3 ug/filter
Sulfur Dioxide	Potassium hydroxide treated filters	NIOSH method PC&AM 268	10 ug/filter

B. Medical

On April 25, 1980, blood and urine specimens were obtained from the three workers currently employed in the pug mill area. The blood samples were analyzed for lead utilizing the Delves-Cup-Atomic Absorption-Procedure, with a detection limit of 6 ug/100 ml. The urine samples were analyzed for arsenic levels utilizing the procedure of Pierce, et. al., Applied Spectroscopy, Volume 30: 38-42, 1976, with a detection limit of 3 ug/L.

V. EVALUATION CRITERIA

A. Environmental

SUBSTANCE	NIOSH RECOMMENDED STANDARDS 10 HOUR TWA	CURRENT OSHA STANDARDS 8 HOUR TWA
Arsenic	2 ug/cu m*	10 ug/cu m
Cadmium	40 ug/cu m	100 ug/cu m (fume) 200 ug/cu m (dust)
Copper	-	0.2 mg/cu m (fume) 1.0 mg/cu m (dust)
Lead	50 ug/cu m	50 ug/cu m
Sulfur Dioxide	2 ppm	5 ppm

*As determined by a 15 minute sampling period.

Occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an eight-hour per day, forty-hour per week basis over a normal working lifetime.

B. Medical

Blood lead levels greater than 40 ug/100 ml are regarded as abnormal. Urine arsenic levels in community populations are usually less than 50 ug/1 (16). Levels greater than 100 ug/1 are regarded as abnormal, possibly representative of excessive occupational exposure and requiring repeat testing for confirmation. (4, 7)

C. Toxicology

1. Arsenic

Inorganic arsenic poisoning can be acute or chronic. The general public is exposed to arsenic in some foods, primarily seafood. Occupational exposure is by inhalation (breathing), direct skin and mucous membrane contact, and ingestion (contamination of hands, food, and smoking material).

Manifestations of chronic inorganic arsenic poisoning include dermatitis, warts, hyperkeratoses ("calluses") of the palms and soles, conjunctivitis, respiratory tract irritation, ulceration and perforation of the nasal septum, headache, drowsiness, confusion, convulsions, anemia and muscle weakness. Arsenic is a cause of skin cancer and lung cancer, and is possibly a cause of a rare liver cancer, angiosarcoma. Smelter workers as a group have increased (non smoking habit related) lung cancer death rates.

Normal urine arsenic levels vary greatly, primarily depending on arsenic levels in the diet. Urine arsenic levels in community populations are usually less than 50 ug/1. Levels greater than 100 ug/1 are regarded as abnormal, possibly representative of occupational exposure. Because of the variability of arsenic levels, anyone found to have a level greater than 100 ug/L should be re-tested to confirm the finding. (1,2,3,4,5)

2. Copper Mist, Dust and Fume

Inhalation of dusts and mists of copper and copper salts result in irritation of the upper respiratory tract and, occasionally, ulceration and perforation of the nasal septum. Metal fume fever, a 24-28 hour illness characterized by chills, fever, aching muscles, dryness in the mouth and throat, and headache may occur due to exposure to metal oxide fume rather than copper dust. Copper particles embedded in the eye result in a pronounced foreign body reaction, with characteristic discoloration of eye tissue.

Allergic contact dermatitis due to copper, although rare, has been reported.

3. Lead

Lead accumulates in the body and is excreted slowly. The general public is exposed to small amounts of lead in food, water, and air. Occupational lead exposure is primarily by inhalation, and to a lesser degree by ingestion (contamination of hands, food, and smoking material). Lead poisoning is a chronic process, although symptoms may develop suddenly after sufficient chronic exposure. Manifestations of lead poisoning in adults include decreased appetite, abdominal pain, nausea, constipation (or diarrhea), fatigue, irritability, insomnia, headache, anemia, muscle pain, sore joints, tremor, weakness of the extensor muscles of the wrists and ankles, and impaired kidney function. There is some evidence that occupational lead toxicity can impair fertility.

Blood lead levels below 40 ug/100 ml whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100 ml. Lead levels between 40-60 ug/100 ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100 ml are considered dangerous and often require hospitalization and medical treatment. (7, 8, 9, 10)

4. Sulfur Dioxide

a. Acute (short term) effects

Sulfur dioxide is a chemical gas which combines with water on moist surfaces to form sulfurous acid. This acid, like all acids, causes reddening and stinging irritation to skin surfaces and mucous surfaces (for example, nose, throat, eyes and lungs). Thus, persons exposed to sulfur dioxide gas at concentrations of 20 parts of gas in every million parts of air (20 ppm) experience choking and sneezing. Exposure to 50 ppm usually causes nosebleeds, runny nose, watering, stinging eyes, cough, difficulty breathing, and wheezing due to airway narrowing in the lungs. Very high levels of sulfur dioxide can cause pneumonia and/or permanent scarring of lungs (bronchiolitis obliterans).(11)

b. Chronic (long term) effects:

Studies of long-term, low level (less than 10 ppm) sulfur dioxide exposure have given conflicting results (12, 13, 14, 15). Careful standardization of spirometry procedures and a clear separation between exposed and control groups are necessary to provide meaningful results in such studies. When these precautions are respected, studies indicate significant reduction in lung capacity (FVC) and expiratory flow rate (FEV-1) for workers exposure to sulfur dioxide (0.5 - 3 ppm) within the current standard (5). An increase in chronic bronchitis and "days off" due to respiratory illness was reported in the same group of workers. These findings were not explained by respondents' smoking habits. Altogether, the data suggest that chronic low level sulfur dioxide exposure can cause or accelerate the development of chronic bronchitis and emphysema (obstructive lung disease).

VI. RESULTS AND DISCUSSION

A. Environmental

Individual air sample results are shown in Table 1. All four of the personal samples for arsenic (24, 94, 14 and 32 ug/cu m) exceeded the OSHA standard of 10 ug/cu m. One of the four personal samples for copper dust (2.16 mg/cu m) exceeded the standard of 1 mg/cu m and one lead sample (95 ug/cu m) exceeded the standard of 50 ug/cu m. Samples collected on the NIOSH observer when the pug mill operator was banging on the hopper to loosen dust inside the hopper show that this operation is one of the heavy contributors to the pug mill operator's eight hour average exposures. During this operation, the worker wears a respirator. All the cadmium samples were less than 4 ug/cu m and the sulfur dioxide samples ranged from 0.01 to 0.1 ppm which are well below the current OSHA standard or NIOSH recommended levels.

B. Medical

One worker was found to have a urine arsenic level greater than 100 ug/l, and was encouraged to have a repeat urine sample tested for arsenic. All 3 workers' urine arsenic levels were greater than 50 ug/l.. All workers tested had blood lead levels less than 40 ug/100 ml. The results are listed below.

Urine Arsenic Levels As ug/L corrected for S.G.		Blood Lead Levels Pb ug/dl	
worker No. 1	56	worker No. 1	31
worker No. 2	73	worker No. 2	24
worker No. 3	130	worker No. 3	19

Based on these findings, there is no medical evidence of excessive lead exposure, but one case of possible excessive arsenic exposure. This was substantiated by airborne arsenic levels that ranged from 14 to 94 ug/cu m.

VII. RECOMMENDATIONS

1. The current OSHA regulations for exposure to arsenic and lead are very specific and need to be consulted. These regulations cover personal protective equipment and clothing, identification of exposure areas, personal hygiene, medical requirements and other items. Workers should be informed about the requirements for such procedures which are mandated under the appropriate standards.

2. Repair all leaks in the hopper.

3. Keep the appropriate number of bolts in each hopper access cover.

4. Clean the area under the hopper with a vacuum source on a regular basis.

5. Keep the road past the pug mill wet.

6. Consider providing a booth or shelter with filtered air, near the control area.

7. Repeat urine arsenic sampling on an annual basis, and medical surveillance as described in Appendix A.

8. The company should provide a workers education program regarding the potential health hazards of lead and arsenic.

VIII. REFERENCES

1. OSHA Safety and Health Standards (29 CFR 1910.1018) - Inorganic arsenic.

2. NIOSH Recommended Standard for Occupational Exposure to Inorganic Arsenic, U.S. Government Printing Office: 1974 657-061/2015.

3. Hine, C.H., Pinto, S.S., Nelson, M.S., Medical Problems Associated with Arsenic Exposure, J. Occ. Med., Vol. 10, No 6, 1977.

4. Harrison, R..R., etc. al, Ed., The Principles of Internal Medicine, McGraw-Hill, New York, 1980.

5. Iyengar, G.V., et. al, Elemental Composition of Human Tissues.

6. Proctor, N.H., Hughes, J.P., Chemical Hazards in the Workplace, J.P. Lippincott Co., Philadelphia, 1978.

7. National Institute for Occupational Safety and Health: Criteria for a Recommended Standard...Occupational Exposure to Inorganic Lead, Revised Criteria 1978. DHEW (NIOSH) Publication No. 78-158.

8. Poskanzer DC: Heavy metals, in Isselbacher KH, Adams RD, Branwald E., Petersdorf RG, Wilson JO (eds): Harrison's Principles of Internal Medicine, 9th ed. McGraw-Hill Book Co., New York, 1980, pp 967-968.

9. Metals and metalloids, in Zenz C(ed): Occupational Medicine, Chicago, Year Book Medical Publishers, 1975, pp 613-713.

10. Lancranjan I, Popescu HI, Gavanescu O, Klepsch I, Serbanescu M: Reproductive ability of workmen occupationally exposed to lead. Arch Environ Health 30: 396-401, 1975.

11. U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health: Criteria for a Recommended Standard ... Occupational Exposure to Sulfur Dioxide, Washington D.C., 1974.

12. Smith, T.J., Peta, J.M., Reading, J.C., and Castle, H.C., : Pulmonary impairment from chronic exposure to sulfur dioxide in a smelter, Am Rev Respir Dis 116: 31-39, 1977.

13. Lebowitz, M.D., Burton, A., and Kalterborn, W.: Pulmonary function in smelter workers, J. Occup Med., 21: 255-259, 1979.

14. Federspiel, C.F., Layne, J.T., Auer, C., Bruce, J.: Lung Function among employees of a copper mine smelter, J. Occup. Med., 22: 438-444, 1980.

15 Archer, V.E., NAD Gillam, J.D.: Chronic sulfur dioxide exposure in a smelter, J. Occup. Med, 20: k88-95, 1978.

16. P.J. Landrigan: Arsenic; State of the Art, Environmental Health Perspective (in press).

IX. ACKNOWLEDGEMENTS

Report prepared and survey conducted by:

Arvin G. Apol
Industrial Hygienist
Region X/NIOSH
Seattle, Washington

Molly Coye, M.D.
Medical Officer
Region IX/NIOSH
San Francisco, California

Survey assistance by: Pierre Belanger, NIOSH
Rocky Mountain Center For
Occupational Safety and Health

Originating Office:

Hazard Evaluation and Technical
Assistance Branch
DSHEFS/NIOSH
Cincinnati, Ohio

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this complete Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. ASARCO, Inc.;

2. United Steel Workers, Local 886;

3. U.S. Department of Labor, Occupational Safety and Health Administration, Region IX, San Francisco, California;

4. National Institute for Occupational Safety and Health, Region IX, San Francisco, California.

For the purpose of informing the five affected employees, the employer shall promptly post this Determination report in a prominent place(s) near the work area of the affected employees for a period of thirty (30) calendar days.

APPENDIX A

MEDICAL SURVEILLANCE

Medical surveillance should be made available as specified below for all workers occupationally exposed above the action level for arsenic, without regard to the use of respirators, at least 30 days per year.

Pre-placement and annual medical examinations should include:

1. Comprehensive work history and medical history which should include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum production and wheezing.

2. Careful examination of the skin for the presence of hyperpigmentation, keratoses, or other chronic skin lesions. Care should be taken to observe and record the location, condition, appearance, size and any changes in all such lesions. Any worker demonstrating arsenical dermatitis should be carefully monitored, and should there be any progression of this disease he should be removed from exposure to arsenic and its compounds.

3. If the employee for any reason develops signs and/or symptoms commonly associated with exposure to inorganic arsenic, the employer should provide an appropriate examination and emergency medical treatment.

4. The worker should be informed of the results of all medical and environmental monitoring and this information should be kept in his medical file at work, as should any employee with health complaints related to exposure to inorganic arsenic.

5. These records should be retained for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

TABLE I

PUG MILL
ARSENIC, CADMIUM, COPPER, LEAD AND SULFUR DIOXIDE
AIR CONCENTRATIONS

ASARCO
Hayden, Arizona

JOB	SHIFT	DATE	SAMPLE #	SAMPLE TIME (min.)	SAMPLE VOLUME (lit.)	Arsenic ug/cu m	Cadmium ug/cu m	Copper mg/cu m	Lead ug/cu m	Sulfur Dioxide ppm
Pug Mill Operator	1	4/23/80	22	385	577	24	-	-	-	0.01
Pug Mill Operator	1	4/23/80	21	385	577	-	3	0..12	12	0.01
Pug Mill Operator	1	4/23/80	26	370	555	94	-	-	-	0.01
Pug Mill Operator	1	4/23/80	23	370	555	-	4	2.16	95	0.03
Pug Mill Operator	1	4/24/80	38	430	645	14	-	-	-	0.02
Pug Mill Operator	1	4/24/80	36	430	645	-	4	0.47	6	0.01
Pug Mill Operator	1	4/24/80	37	435	652	32	-	-	-	0.04
Pug Mill Operator	1	4/24/80	33	395	592	-	3	0.49	30	0.01
Area Sample at Control Panel	1	4/23/80	27	415	622	-	3	0.13	18	0.03
Area Sample at Control Panel	1	4/24/80	39	430	645	-	3	0.1	4	0.05
Area Sample between lines 14 & 15	1	4/23/80	28	405	607	12	-	-	-	0.02
Area sample between lines 13 & 14	1	4/24/80	34	415	622	-	3	0.05	14	0.08
Area sample line 3	1	4/23/80	29	400	600	-	3	0.01	7	0.1
Area sample between lines 5 & 6	1	4/24/80	40	415	622	30	-	-	-	0.04
NIOSH observer line 8*	1	4/23/80	35	10	15	-	ND	2.3	200	-
NIOSH observer lines 1-3*	1	4/24/80	32	10	15	-	ND	2.1	267	-

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396